

THE ANALYST.

MAY, 1895.

PROCEEDINGS OF THE SOCIETY OF PUBLIC ANALYSTS.

The monthly meeting of the Society was held on Wednesday evening, April 3, at the Chemical Society's Rooms, Burlington House. In the absence of the President, Mr. Otto Hehner took the chair.

The minutes of the previous meeting were read and confirmed.

The following gentlemen were proposed for election as members of the Society: Mr. H. Irving Foster, The Elms, Anlaby Lane, Hull, formerly assistant, and now partner, of Mr J. Baynes; and Mr. Alexander Poole Wilson, Analytical Chemist, Knocklong, co. Limerick.

Papers were read on the following subjects:

"The Composition of some English Cheeses." By W. Chattaway, T. H. Pearmain, and C. G. Moor, M.A.

"The Testing of Oils by the Oleo-refractometer." By T. H. Pearmain.

"Some Errors in Commercial Weighing." By S. Rideal, D.Sc.

The publication of these is unavoidably held over.

THE INTERPRETATION OF THE RESULTS OBTAINED UPON THE CHEMICAL AND BACTERIOLOGICAL EXAMINATION OF POTABLE WATERS.

JOHN C. THRESH, D.Sc., M.B., D.P.H., F.I.C.

Medical Officer of Health to the Essex County Council.

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The microbes found in water are chiefly bacilli. Micrococci are comparatively rare, whilst spirilla are not uncommon, especially in polluted waters. Already over two hundred distinct species of microbe have been discovered in potable waters, and amongst these are several which are pathogenic, or disease-producing. According to Professor Percy Frankland,* these are:

Typhoid bacillus.
Cholera spirillum, or "comma
bacillus."
Tetanus bacillus.
Anthrax "
Tubercle "
Bacillus brevis.
" capsulatus.

Bacillus proteus fluorescens.
" coli communis.
" hydrophilus fuscus.
" pyocyaneus.
Staphylococcus pyogenes aureus, and
the organisms causing septicaemia
in mice and rabbits.

* *Journal of State Medicine*, January, 1894: "The Bacteriological Examination of Water."

Up to the present, however, the only diseases which are known to be caused by drinking specifically-infected water, and the micro-organisms of which have been with certainty discovered in such waters, are cholera and typhoid fever. Doubtless, further research will add to this short list, but as yet the organisms causing malaria, dysentery, and other diseases, believed to be produced by specific microbes entering the system with the drinking water, have not been actually identified therein. The utmost, therefore, that can be expected of the bacteriologist is that he should discover and identify the cholera or typhoid bacillus, should either of these organisms be present in a sample of water submitted to him for examination. The multitude of other bacilli present, however, renders this a difficult and often impossible task; the search has been likened to the finding of a needle in a stack of hay. Whilst, therefore, the absolute identification of the specific cause of cholera or typhoid fever establishes its presence, the failure to isolate it is no proof of its absence. As a matter of fact, numerous samples of water, credited with the production of one or other of these diseases, have been examined with negative results. As examples may be quoted the examinations of the water supplies to Hamburg and Altona during the cholera epidemic, and the water supplies to Worthing, and to the towns in the Tees valley, during the outbreaks of typhoid fever, which recently occurred there. Although the Elbe was known to be polluted with cholera excreta, the comma bacillus was never discovered in the imperfectly-filtered river water, to the use of which Koch and others, who investigated the outbreaks, attributed their occurrence. At the commencement of the second serious epidemic of typhoid fever at Worthing, two samples of the water were submitted to bacteriological examination by Professor Crookshank. He found that they contained far fewer bacteria than the water supplied to King's College, and that there was a marked absence of liquefying colonies. "There was no colony of typhoid fever bacilli, and no bacillus to which suspicion could be attached of producing typhoid fever." He concluded, from the results of his bacteriological examination, "that both samples of the Worthing water rank as very pure water." Considering that during the construction of additional works in the spring, a fissure was opened which discharged into the wells a large volume of water, polluted by surface drainage, and leakage from defective sewers, and that this mixture of well and surface water thereafter was supplied to the town, and was the water examined by Dr. Crookshank, it is not surprising that the results of these and other examinations were considered by the public as "most remarkable." Chemical examinations made from time to time also failed to detect any pollution. The following statements, made by the Deputy Mayor of Worthing* at a meeting of the Town Council, held July 18, 1893, are particularly interesting, not only as showing how little reliance can be placed upon either the bacteriological or chemical examination of drinking waters, but also as showing the disastrous results which may follow misplaced confidence in these results. The Deputy Mayor, at the above meeting, after speaking of the finding, about two months ago, of the fissure which gave to the town an enormous additional yield of water, said: "We congratulated

* From Report in the *Sussex Coast Mercury*, July 22, 1893. Worthing has a population of about 17,000, and during the year 1893 nearly 1,500 cases of typhoid fever occurred. (It is only fair to add that previous samples of water from the same source had been condemned by Professor Crookshank as showing unquestionable evidence of pollution by filth.)

ourselves upon that fissure, but I think there is no doubt, and certainly no member of the Sanitary Committee has any doubt, that it is to that very fissure the whole of the difficulty we are sustaining, and have sustained, is entirely due." He then referred to the various chemical and bacteriological analyses which had been made, resulting in the water being pronounced thoroughly good and pure. Notwithstanding these results, the committee cautioned the public that they should boil the water, and the boiling went on until the first outbreak practically ceased. "We were hoping," he said, "that the difficulty had ceased, and that we were to have no more typhoid among us; but, unfortunately, another analysis was made by Dr. Crookshank, the water being taken from two or three different sources, and each sample was declared to be good. 'Perfectly pure' were, I think, the doctor's words. Well now, to that, I am afraid, to some extent, we may attribute the cause of the second outbreak. It was stated publicly, with the best intentions, to allay public excitement and the panic which was prevailing, that the water was perfectly pure, because we had the best evidence that it was so; and I have no doubt that the public, who do not like the trouble of boiling every drop of water they drink, ceased the boiling, and thus the second outbreak came upon us, and is still going on." It is quite unnecessary to point the moral of this plain statement of facts. As it has been found impossible to dam out the water from the prolific, but fatal fissure, the present source of supply is being abandoned. A proposal to attempt the purification of the water by filtration through sand has not been acted upon, Dr. Thorne having brought under the notice of the Sanitary Authority Professor Koch's experience, to the effect that, "even under favourable circumstances, sand filtration cannot give absolute protection against the danger of infection." During the Tees valley epidemic also the water was repeatedly examined bacteriologically. Although an excessive number of micro-organisms was found, sufficient, in fact, to justify the opinion that the water was polluted, the typhoid bacillus was not once discovered.

It has recently been pointed out that the so-called typhoid bacillus (Eberth's) is often absent from typhoid stools, and that the *bacillus coli communis*, which is invariably found in all stools, is capable under certain conditions (probably by growth in cesspools and sewers) of acquiring pathogenic properties in man. It is even, by many, believed that this is either a degenerate form of Eberth's bacillus, or that it is capable of taking on the same properties, and of causing the same disease—typhoid fever. Such being the case, all waters fæcally polluted may be capable of producing this disease when all the circumstances are favourable, and, therefore, must be looked upon with the gravest suspicion, whatever the results of bacteriological or chemical analyses.

All surface waters contain large numbers of micro-organisms, but freshly-drawn deep-well waters, and waters from deep-seated springs, are almost sterile. When such pure waters are kept for a few days, however, the number of micro-organisms increases enormously. Professor P. Frankland says that such a water, containing only, say, five microbes per cubic centimetre when freshly drawn, may, even if kept in a sterile flask and protected from aerial contamination, contain, after a few days, perhaps 500,000 in the same volume, or, in other words, as many as are found in slightly-diluted sewage. He points out, however, that whilst in sewage the numbers

only gradually diminish, in these pure waters, "after the rapid increase in numbers, follows a correspondingly rapid decline, so that the numbers again very soon fall below those found in impurer surface waters." It follows, therefore, that the purest water which has been kept a few days may be confounded with a water from the filthiest source, and that even if the number of micro-organisms found in a water is to be taken as a criterion of its purity or otherwise, the bacteriological examination must be made before such multiplication can have ensued. In freshly-drawn deep-well and spring waters there should be few or no bacteria; in the purest mountain streams and lakes there should not be more than a few hundreds in a cubic centimetre (15 drops). In ordinary river waters from 1,000 to 100,000 may be found in the same volume, whilst in sewage there may be several million. Rain, hail, snow, and ice are not free from bacteria, though usually the number contained therein is small.

In 1887 Professor W. R. Smith made a series of experiments for the Local Government Board (*vide* Report of the Medical Officer, 1887) on the differentiation and identification of micro-organisms found in water supplies. The results gave evidence of the multifarious character of the organisms in question, and illustrated the need for caution against drawing general conclusions from the results of cultivating water organisms by any single method. In the same year Dr. Dupré, F.R.S., reported to the Board on changes effected in the aeration of certain waters by the life processes of particular micro-organisms under different conditions of temperature, light, and nutrient material, but the results obtained seem of no practical value. "The process of oxygen consumption was found, as might be expected, to be influenced by these circumstances, but it would not yet be safe to formulate general inferences from the facts."

Koch, in an able article on Water Filtration and Cholera,* has endeavoured to set up a standard of purity based upon the number of bacteria, capable of cultivation in certain media, contained in a given quantity of the water. He would regard even filtered river water containing over 100 micro-organisms in a cubic centimetre as open to suspicion; but, as we have just seen, he does not regard such water, if once polluted, as absolutely safe, however careful and thorough the filtration; but to this question we shall have shortly to refer again. The Royal Commissioners on Metropolitan Water Supply do not entirely concur with this conclusion. They point out that the typhoid bacillus is, so far as is known, only found in human excrement, and that it has not yet been found to retain its vitality when in faecal matter for more than fifteen days; that in all ordinary waters there exist organisms which "undoubtedly exert an influence in diminishing the vitality of the typhoid bacillus; that exposure to direct sunlight destroys these bacteria; that they have a tendency to subside more or less rapidly in all slowly-moving waters, and to be carried down with other matters held in suspension; and that there are strong grounds for believing that small doses either of cholera or of typhoid poison may be swallowed with impunity. Such being the case, they fall back upon the "evidence of experience," and whilst acknowledging that the various water supplies to London are contaminated with sewage, which may, and often does, contain the specific poison of typhoid fever, and may contain the bacillus of Asiatic cholera, they "state without hesitation,

* Translated by J. A. Ball, Esq., and published by the Local Government Board.

that, as regards the diseases in question, which are the only ones known to be disseminated by water, there is no evidence that the water supplied to the consumers in London by the companies is not perfectly wholesome." In other words, these polluted river waters, which have undergone a filtration far less perfect than that required by Koch, since London water usually contains many hundreds of micro-organisms in the cubic centimetre, are perfectly safe and wholesome.

Many bacteriologists now accept the number of micro-organisms present in a water as the measure of its pollution, and some have not hesitated to approve or condemn waters according as they contained few or many organisms, even where the results of chemical analyses directly contradicted their conclusions.

The attempt to set up a standard of purity based upon the number of micro-organisms in a given quantity, is as illogical as the old chemical standards. Both depend upon quantity, whilst the real point at issue is the quality. In reputedly good waters it has been observed that the micro-organisms present capable of liquefying gelatin by their growth are few in number, whilst in sewage-polluted waters they abound; but this fact is of little value, since it only enables somewhat gross pollution to be detected, and most of these liquefying organisms are perfectly harmless. Bacteriology, like chemistry, may tell us something of hazard and impurity, but neither can be depended upon to determine with certainty whether a water is actually injurious to health. To condemn one water because it yields a little more albuminoid ammonia than another, or because it contains a few more organisms than another, when we know nothing of the nature of the substance yielding the ammonia, and nothing of the character of the organisms, is obviously so illogical as to be absurd, and yet this is what is almost invariably done. Bacteriological, microscopical, and chemical examinations must always be associated with a thorough investigation of the source of the water, to ascertain the possibility of contamination, continuous or intermittent. Then, and then only, if everything be satisfactory, we may be justified in speaking of safety and of freedom from risk; but where either the bacteriological, microscopical, or chemical examination is unsatisfactory, the inquiry into the history of the water must be most careful and complete, and a guardedly-expressed opinion given only after a full consideration of the bearing of the one upon the other. The possibility of accidental pollution is a point too often overlooked; yet it is to such accidental pollution that outbreaks of disease are most frequently attributed, and of this the examination of samples of water prior to the occurrence of the contamination may tell us little or nothing. The danger of such pollution does not, unfortunately, vary with the amount of any constituent found in the water, and a source yielding a water of great chemical and bacterial purity may be more liable to occasional fouling than a source yielding water containing excessive quantities of chlorides and nitrates, or even of unoxidized organic matter, or large numbers of living organisms.

Although a mere analysis cannot guarantee us purity and safety, yet it very frequently can reveal to us impurity and risk. When the source of a water, upon most careful examination by an expert, is found to be free from all danger of pollution, and the chemical examination proves that the inorganic constituents are unobjectionable both in quantity and quality, and that organic matter is absent or present in barely appreciable amount, then safety, so far as human foresight can be trusted,

may be guaranteed. If organic matter be present in appreciable quantity—that is, if the water yield such a quantity of organic nitrogen and carbon, or albuminoid ammonia, or requires such an amount of permanganate for oxidation as to render it of suspicious or of doubtful purity—a study of the history of the water and of its geological source may, and generally does, enable an opinion to be formed as to the nature of the organic matter, and as to whether it is of an innocuous or dangerous character. Chemical analysis, therefore, has its use; it is only when it is made the sole arbiter between safety and risk that it is abused, and is liable to lead to errors fraught with most disastrous consequences. Let the analysis be as careful and complete as possible, but let the results always be interpreted in the light afforded by a searching examination of the source of the sample. Let all so-called standards be abandoned as absurd, and let the opinion as to whether water is dangerous or safe be based upon a full consideration of other and more important factors.

On the opposite page are arranged in a tabular form the results of the chemical analysis of a number of waters which are reputed to have caused serious outbreaks of typhoid fever, yet were passed by analysts of repute as good potable waters. A few other analyses are also inserted to exemplify points discussed in the paper. The following remarks bearing upon each of the analyses supplement the table.

Remarks.

1. Analysis of water from the river Ouse below where it receives the sewage of Buckingham. Examined for the Town Council, February 29, 1888, by W. W. Fisher, Public Analyst. Report: "Does not appear from the analysis to contain sewage matters." Quoted by Dr. Parsons in his report to Local Government Board on an outbreak of enteric fever in 1888, as a "further illustration of the inability of a chemist to prove the quality of organic matter in water when its quantity is small."

2. Analysis of the Buckingham public water supply by Mr. Fisher. Certified by him to be a first-class water, yet believed by Dr. Parsons to have been the cause of the above outbreak.

3. Analysis of the Beverley water supply from borings in the chalk by Mr. Baynes, July 18, 1884. In 1884 an outbreak of typhoid fever occurred here, and was investigated for the Local Government Board by Dr. Page. The evidence led him to conclude that the specific contamination of the water supply was the immediate cause of the outbreak. The water had been repeatedly analysed, and the analysis given was made "on the very border of the period when the water was acting as the epidemic agent." It was certified to be "of a very high degree of purity, and eminently suitable for drinking and domestic purposes." Specifically infected sewage from an asylum had been spread upon land near the well and reservoir.

4, 5. Analyses of water from the much-polluted Trent at (4) Torksey, and (5) Knaith, by Dr. Tidy, December 20, 1890. The analyst reported that "there is no evidence of the product of sewage contamination." From Dr. Bruce Low's report to the Local Government Board on the occurrence of enteric fever amongst the population using the Trent water, 1893.

6. Analysis of the well water supplying Houghton-le-Spring, April 24, 1889. Early in the month a sudden outbreak of typhoid fever occurred here, and a sample

TABLE OF ANALYSES OF POTABLE WATERS.

NUMBER.	SOURCE OF LOCALITY.	APPEARANCE, ETC.	RESULTS IN GRAINS PER GALLON.										IN PARTS PER MILLION.			
			Total Solids.	Effect of Ignition.	Nitric Nitrogen.	Chlorine.	Temporary Hardness.	Total Hardness.	Organic Carbon.	Organic Nitrogen.	Free Ammonia.	Albuminoid Ammonia.	Nitrites.	Ammonia used in four hours.	Oxygen	used in four hours.
1.	R. Ouse, Buckingham	Turbid and slight weedy odour	22.0	...	.014	1.2	...	...	...	...	.13	.30	Trace	1.30		
2.	Ditto	Bluish tint, good in colour	37.5	...	.07	1.1	...	31.0	...	...	.09	.07	.0	.0		
3.	Beverley Water Supply	...	26.0	...	1.55	19.9	25.6	...	...	...	.00	.01	...	...		
4.	R. Trent, at Torksey	Turbid	26.4	...	.177	2.23	12.7	30.7	.12	.02	.07	...	...	1.34		
5.	" Koraith	...	26.6	...	.177	2.23	11.2	30.8	.12	.02	.09	...	...	1.29		
6.	Houghton-le-Spring supply	Colourless and nearly clear	34.4	...	...	2.1	...	...	...	...	.00	.03	...	.13		
7.	R. Tees water, Middlesbrough Supply,	Pale brown, turbid, peaty taste	7.3	...	.00	.49	.0	3.9	.70	.047	.00	...	...	...		
8.	R. Tees water, Middlesbrough Supply,	Very slightly turbid, peaty taste	9.1	...	.00	.55	1.9	6.1	.30	.010	.00	...	...	...		
9.	R. Tees water, Middlesbrough Supply,	...	10.8	...	.00	.50	...	...	...	...	.02	.12	.0	...		
10.	R. Tees water, Middlesbrough Supply,	Cl-ar, dark yellow	12.0	...	.028	.7	...	...	...	...	.00	.04	...	3.0		
11.	R. Tees water, Darlington Supply,	Light brownish yellow	10.5	...	.036	.84	4.8	8.2	.08	.020	.00	...	...	...		
12.	R. Tees water, Darlington Supply,	Greenish yellow, clear and bright	13.4	...	.011	.35	...	...	...	...	.03	.03	...	...		
13.	R. Tees water, Darlington Supply,	Clear, no peaty taste	7.2	...	.00	.49	...	...	...	...	.04	.11	...	10.4		
14.	R. Tees water, Stockton Supply, Aug., 1891	Dark brownish yellow, almost opaque	8.54	...	...	.8	...	...	.49	...	...	...	...	4.16		
15.	R. Tees water, above Barnard Castle, 1887	...	9.3	...	...	.65	...	...	.354	...	...	...	...	...		
16.	" below ditto (Darlington), 1887	...	7.7	...	Trace	.67	...	...	...	...	.00	.014	.0	4.01		
17.	Mountain Ash Water Supply	Very pale brownish	6.2	Blackened	.025	.16	1.5	5.0	...	...	.013	.033	...	.31		
18.	Massachusetts, Unpolluted Surface Water	Slightly turbid	3.6	...	.020	.58	...	...	...	...	.002	.020	...	...		
19.	Polluted ditto	...	5.0	...	.010	.09	...	...	...	...	.017	.12	...	...		
20.	Merrimack River	...	2.4	...	.001	.09	...	...	...	...	.002	.10	...	...		
21.	Chicopee River	...	2.8	...	...	.16	...	...	...	...	.014	.24	...	...		
22.	Boston Supply. Purest reservoir	...	2.7	...	.04	1.3	...	...	...	...	.21	.24	...	...		
23.	Boston Supply. Mystic lake	...	7.4	...	.13	25.6	4.0	4.1	...	...	.20	.05	.0	.75		
24.	Essex. Deep well	...	95.0	Slightly charred	...	...	...	...	...	...	.01	.24	...	...		
25.	Same well, a few weeks later...	Blackened	113.0	Blackened	1.44	14.8	17.0	19.0	...	...	.02	.08	...	3.25		
26.	Shallow well, near surface	Brownish	94.0	Brownish	4.14	16.1	13.5	35.0	...	...	.02	.12	...	1.75		
27.	Same well, near bottom	Charred	119.0	Charred	4.33	22.0	17.3	45.5	...	...	.02	.12	Trace	2.50		
28.	Well at Melton Asylum, Oct. 11, 1893.	Turbid and yellow	42.	...	...	12.7	...	...	...	...	.20	.09	...	.43		
29.	" Oct. 23, 1893.	...	45.5	...	...	6.4	...	...	...	...	.29	.24	...	.33		
30.	" Feb. 9, 1894.	...	23.	...	.0	7.2	...	...	...	...	.24	.20	...	.62		

of the water was at once sent for analysis. The analyst reported: "This water is very free from indication of organic impurity. . . . It is a good water for drinking purposes." Dr. Page, who investigated this outbreak for the Local Government Board, found that sewage from a farm three-quarters of a mile away was discharging into the well at a point 45 feet from the surface.

7-14 form a very interesting series of analyses by chemists of the highest repute, of the Tees water as supplied to the towns in the Tees Valley. Two outbreaks of enteric fever occurred in these towns, the first between September 7 and October 18, 1890, and the second between December 28, 1890, and February 7, 1891. Dr. Barry reported upon them to the Local Government Board. He found the river above the intake of the water companies excessively polluted by sewage, cesspool drainage, etc. It is with reference to the relation of this water to the typhoid epidemics that Dr. Thorne says: "Seldom, if ever, has the proof of the relation of the use of the water so befouled to wholesale occurrence of typhoid fever been more obvious or patent." The analyses now quoted were made before, during, and after the epidemic periods, yet, as will be seen, in not a single instance did the chemical examination indicate either pollution or danger.

7. Analysis of the Middlesborough water supply by Dr. Frankland, F.R.S., August 23, 1890. Report: "Peaty . . . but in all other respects the water is of excellent quality for domestic use, *and it is free from any trace of sewage contamination.*"

8. Ditto, October 23, 1890. Report: "With the exception of a peaty taste, it is in all respects of excellent quality for dietetic and all other domestic purposes."

9. Analysis of the Middlesborough water supply by A. H. Allen, F.I.C., October 27, 1890. Report: The results "negative any suspicion of contamination of sewage or cesspool drainage. . . . No suspicious results were obtained on bacteriological and other microscopical examination."

10. Analysis of the Middlesborough water supply by Messrs. Pattinson and Stead, October 29, 1890. Report: "Perfectly wholesome and free from any sewage contamination. . . . The microscope reveals nothing of an objectionable character."

11. Analysis of the Darlington water supply by F. K. Stock, County Analyst, December 2, 1890. Report: "I have no hesitation in saying that the Tees water as at present being supplied to consumers is of good and wholesome quality."

12. Analysis of the Middlesborough water supply by Dr. Frankland, F.R.S., January 1, 1891. Report: "Of excellent quality for dietetic and all domestic purposes."

13. Analysis of Darlington water supply by W. F. K. Stock, County Analyst, February 9, 1891: "I am of opinion that the Tees water as supplied to the town on January 29, 1891 (the date when the sample was taken), was good and wholesome drinking water."

14. Analysis of the Stockton water supply by A. C. Wilson, Borough Analyst, August, 1891. Report: "Heavily charged with organic matter of vegetable origin. There is, however, no appearance of animal pollution."

That the river Tees some miles above the company's intake is grossly polluted

with sewage no one has denied, yet these waters, upon analysis, were said to be pure and wholesome, and free from any trace of sewage contamination. As they are stated by the most competent authorities to have been the cause of the extensive epidemics of typhoid fever, most of them must have been absolutely poisonous at the time they were examined.

15, 16. In 1887, when an inquiry was being held to investigate the pollution of the river Tees, the late Professor Tidy examined a number of samples of water therefrom. No. 15 is the mean of several analyses of samples taken above where the river receives the sewage of Barnard Castle, and No. 16 is the mean of several analyses of samples taken at Darlington, fifteen miles below Barnard Castle. Notwithstanding the sewage poured in at this town, and at points nearer Darlington, Dr. Tidy reported that the water at the latter place was rather better than at the former, and was good and wholesome. He adds: "I am of opinion that if the quantity of sewage discharged into the river at Barnard Castle was enormously greater than at present, the self-purifying action of the water would be amply sufficient to oxidise every trace of sewage impurity within a short distance of the outfall. Further, I am of opinion that Darlington would not be prejudiced (although the river is the source of the water supply) even if an outbreak of fever or cholera were to occur at Barnard Castle."

17. Mean of four analyses of the Mountain Ash water supply (spring and surface water) by Dr. Dupré, November, 1887. A serious outbreak of typhoid fever occurred here, commencing in July, 1887, and continuing until October. Mr. John Spear investigated it for the Local Government Board, and attributed the epidemic to insuccion of filth into one of the water mains during intermission of the service. Dr. Dupré found the samples almost identical from a chemical point of view, and very pure and free from any indication of sewage pollution. The two samples, however which were taken from the taps, after six hours' intermission, were found, when examined *microscopically*, to contain fungoid growths and large animalculæ, which were absent from the two other samples.

18-23 are analyses quoted from the *Report of the Massachusetts State Board of Health*, 1890-92.

18. A sample of unpolluted surface water containing more nitrates and yielding more albuminoid ammonia than (19) a sample of surface water known to be polluted by sewage.

20. The average of a series of monthly examinations of the water of the Merrimack River, supplying the town of Lowell during 1891, when typhoid fever was epidemic, and attributed to the water being specifically infected nine miles above the intake.

21. Analysis of water from the Chicopee River, supplying the city of Chicopee. Specific pollution is believed to have taken place seven miles above the intake, and to have caused an outbreak of typhoid fever in the city.

22. Analysis of the water from No. 4 reservoir, the purest of the four water supplies to the city of Boston, and (23) of the water from Mystic Lake, the most impure supply, showing that the albuminoid ammonia yielded by the latter does not exceed that yielded by the former.

24, 25 are waters from a deep well in Essex ; (24) collected during dry weather ; (25) collected eighteen hours after very heavy rain. This well water is liable to most serious pollution, yet a report based merely upon the results of the first analysis would most certainly have been favourable.

26, 27 are waters taken by me from the same well ; 26 from near the surface, and 27 from near the bottom.

28, 29, 30. Water from a carefully-constructed bored well, which is believed by Dr. George Turner to have been the cause of a fatal outbreak of dysentery. The variation in character led Dr. Turner to suspect that surface water was being pumped from the bore-tube, and upon pouring a solution of lithium chloride into a hole dug by the side of the tube, lithium was soon afterwards found in the water drawn from the tube.

DISCUSSION.

Mr. HEHNER said he thought Dr. Dupré's paper came not a moment too soon. However great the benefits of that branch of science had been in other divisions of knowledge, far too much importance had been attached to bacteriology in connection with the examination of water. When bacteriology was first introduced into water-analysis, a mere counting of the number of organisms was thought to be sufficient, without taking into account the nature of the organisms themselves. This position was soon shown to be obviously untenable. A distinction was then made between organisms liquefying gelatin and those devoid of that property. This distinction also broke down ; many harmless bacteria liquefy gelatin, while many pathogenic bacteria fail to liquefy this medium. At the present time work was directed into more scientific channels, but a point had hardly been reached when definite results were readily obtainable. No doubt, in many cases, after outbreaks of disease, definite pathogenic organisms had been discovered in certain water-supplies, but bacteriology in such cases came after the event. The chemist had taken a perfectly distinct attitude ; when his analytical data indicated sewage pollution, he had warned against the use of the supply, sewage being potentially dangerous, not necessarily injurious. Thousands of cases could be cited in which chemistry had thus been of the greatest value, while he had yet to hear of the first case in which bacteriology, as applied to water-examination, had done similar service. Chemists certainly could not say, upon their most definite results, that any sample they might examine was actually injurious to health ; but surely modern sanitation did not require such proof, when the presence of danger, in the form of pollution, was established. If bacteriology could be applied so as to assist the chemist in this respect it would be most heartily welcomed, but at the present time it did not appear to be sufficiently advanced to do this. Even in fluids where pathogenic bacteria were bound to be present, most careful search had not unfrequently failed to pick them out from the countless numbers of harmless ones. Thus Mr. Laws, in his recent report to the London County Council, showed that he had to go to the sewers quite close to fever hospitals before he succeeded in discovering in London sewage any typhoid bacilli. If bacteriology was to be taken as the sole guide, it would follow from this report of Mr. Laws, as also from a previous one, that the best air to breathe in London was that of the sewer, and the

safest liquid to drink was sewage itself; propositions so obviously absurd and contradictory to established experience that they needed no refutation.

Although bacteriology was thus at the present time incapable of materially assisting the chemist, it had yet done a great deal of harm, and undeserved discredit had been thrown upon chemical analysis upon the strength of a few exceptional cases of pollution where typhoid excreta had been directly introduced into water-supplies. While sound knowledge on the subject of the chemistry of water could only be obtained by years of work and experience, it appeared very seductive, by going through a two or three months' course of bacteriological study, to be able to become a master of the great problem.

He was quite in accord with Drs. Dupré and Thresh as to the fallacy of deciding from the result of a single determination. Nothing short of a very exhaustive analysis, and of a knowledge of the nature and composition of the natural unpolluted water of the district from which a given sample was derived, could enable the chemist to form a safe opinion in most cases. Dr. Thresh had most usefully pointed this out once more, although public analysts had been long agreed upon this point. The warning rather applied to medical men, who were much more apt to judge by arbitrary limits than analysts were.

Dr. GEORGE TURNER agreed with Dr. Thresh that it was not in the province of a medical officer of health to make analyses, and that such work ought not to be put upon him. It was, beyond doubt, better that it should be done by a chemist, who, having received a special training, would be more likely to do it satisfactorily. His opinion with regard to bacteriology was that it would one day take a very important part in the examination of water for drinking purposes, although it had been severely criticised. He was, however, also of opinion that although an analyst might be able to condemn a water upon his analysis only, it was most undesirable that he should give an opinion that a sample of water was fit to drink or safe upon the same grounds alone, without knowledge as to the presence or absence of possible sources of pollution, and the average composition of the water taken in the locality from the same source.

Dr. J. A. VOELCKER said that a chemist could not go to the extreme of pronouncing any water either absolutely injurious or absolutely safe. If a water were found to give evidence of the presence of sewage in it, it was perfectly justifiable to say that it might at any time become dangerous to health, but he did not think that it would be wise to go further than this. Nobody could doubt that the time would come when bacteriology would become of great assistance in the examination of waters, but hitherto it had been taken up in a very uncertain and dogmatic way, and chemists could not accept it as at present put forward. More definite information was needed as to the nature of the micro-organisms, and as to their behaviour, in order to enable bacteriology to rank as a reliable agent in the examination of water. The comparison of the sample under examination with another from the same source, of which the history was known, was very important, and bore upon what Dr. Dupré had said as to the impossibility of judging correctly by fixed standards, or from the determination of single constituents only. Numerous determinations were necessary, and it was only by a consideration of these in conjunction one with the other that a fair conclusion could be arrived at. It struck him that some public analysts could not have

borne this in mind in undertaking water analyses at the very low fees which they sometimes charged.

Mr. S. F. BURFORD said that he was of opinion that the consideration of any particular water should be governed by the character of the district from which it came, and if it differed to any considerable extent, even in only one particular of importance, from the typical water of the district, its condemnation was justifiable. He had lately analysed several samples of water whose only abnormality was a large amount of chlorine. In one case, a network of drains was situated near the source of the water, and as the typical water of the district contained only a small quantity of chlorine, he felt justified in condemning the sample.

Mr. CASSAL said that the work of water examination should only be undertaken by those who were specially qualified by education, training, and experience. Chemical and bacteriological examinations should only be made by men who were specialists in those branches of knowledge. He held that it was a mistake for medical officers of health to practise analysis, however well qualified some of them might be to undertake that work. Their doing so injured their own profession. Public authorities in some cases forced, or tried to force, their medical officers to undertake analytical work—a course of action which was detrimental to both the medical and chemical profession, as well as to the public.

With regard to the misleading way in which the results of water analyses were often interpreted, the public themselves were to blame for wilfully keeping analysts in the dark as to the source and nature of the supplies from which samples had been taken for examination. It was true that many analytical chemists acted very indiscreetly in regard to the condemnation or passing of samples of water, but so also did many medical men who practised analysis. Absolute safety with respect to a water-supply was a thing that could never be asserted on the strength of chemical or bacteriological examinations, or both combined, not even with the additional information that might be afforded by inspection of sources of supply. A great deal too much had been made of the value of bacteriological methods. Whatever might be thought of a person who passed a water as perfectly safe upon the results of chemical analysis alone, the bacteriologist who ventured to pass a water as safe upon negative bacterioscopic results was a most dangerous enthusiast. Bacterioscopic methods at present afforded nothing more than a test of the roughest and most misleading description for the existence of pollution, and he (Mr. Cassal) would venture to say that by their very nature those methods must of necessity fail to give indications of any great practical value.

Dr. RIDEAL said that it was very useful to know the total nitrogen present in a water, and this could be determined without much labour by the Kjeldahl method. Besides indicating animal pollution, it would also throw light on any toxic poisons that were present in appreciable quantity, and these may be present after the bacteria giving rise to them have disappeared. The phosphoric acid determination had not been referred to, but in some cases it was of great use.

When bacteriology was sufficiently developed to enable the character and nature of the micro-organisms to be identified with certainty, it would be a very valuable assistant, but merely counting the number of organisms was worse than useless.

Dr. DUPRÉ said he had really nothing to answer. He cordially agreed with much contained in Dr. Thresh's paper. It was essential that the chemist should be told everything that was known about the water he had to examine. He himself frequently had had the advantage of working in conjunction with a sanitary engineer, and the results of their joint labours were very satisfactory—far more so than would have been obtained had they worked separately—showing clearly how important it was, in forming an opinion, to be in possession of complete data of all kinds. He was perfectly convinced that no arbitrary standards were possible. One should work by the general standard of the district, as suggested years ago by Mr. Hehner and himself. He pointed out that in stating the results of an examination it was advisable to adhere to one method, as any alteration—such as changing from grains per gallon to parts per 100, or per 1,000, or even, as he had seen, to parts per 1,000,000—had the effect of apparently altering the proportions of different constituents, rendering the analysis at first sight very misleading.

Although absolute safety could not be guaranteed, it was possible, by employing analysis in conjunction with inspection by sanitary officers, to guard against regular and constant pollution, though accidental pollution might occur, and could not be guarded against by any method of examination.

One reason why the results of bacteriological examinations were less reliable was that suspended matters, and especially living organisms, were never so evenly distributed through the water as were the matters in solution dealt with by the chemist, so that a fair sample of any dangerous matters was more likely to be obtained.

The PRESIDENT said that a great deal of acumen and experience were needed in properly interpreting the results of a water analysis. The time had long gone by when the determination of one or two constituents was considered sufficient to enable an opinion as to purity to be formed.

He thought that at present chemistry could say more that was really useful than bacteriology could, although it was probable that in the not very distant future a great deal would be learnt from bacteriology. He did not despise bacteriology, but when from the report of Messrs. Laws and Andrewes it was learned how little of the typhoid bacillus could be isolated from London sewage, he thought it must be concluded that at present bacteriology did not afford so much help as chemistry in the examination of waters.

The following remarks have been received from Mr. W. W. FISHER :

As I was unable to stay for Dr. Thresh's paper, and had not the advantage of hearing it and taking part in the discussion, I should like to offer a few criticisms on the line of argument by which he reaches the conclusion that in most cases the chemical examination of a water is quite useless. I do not believe the inference is valid, that because an analysis is unable to tell you everything about a water such information as it affords is worthless. Every chemist having the responsibility of giving an opinion upon the character of drinking waters must be alive to the fact that an error in judgment may lead to the gravest consequences, either in regard to the life and health of the persons using it, or in respect of hardships and expenditure which

may be caused by groundless condemnation of a water supply, and will therefore agree with the view that all possible information about a water should be obtained. Where important facts as to the origin of a water are not given, they may generally be obtained for the asking; while if from ignorance or other reasons information is refused, surely a chemist is entitled as much as any other professional man to decline to give his opinion on inadequate data.

Dr. Thresh urges on us that "mere chemical analysis is powerless to prove that any water is of such a quality as to be incapable of producing disease"—a statement which has long been in active service in a highly-official capacity. But what more does it amount to than an assertion that analysis cannot prove a negative? What conceivable methods could ever or will ever *prove* a given water incapable of producing disease? But if the assertion means only that after adequate chemical examination there still remains a residuum of doubt and risk, the question is narrowed to one of reasonable probability. I claim that experience has abundantly shown that chemical methods are capable of classifying waters, selecting those which are fit for drinking, and rejecting those unfit for the substantial reason that the use of polluted waters involves manifest risk and danger to health. We are told that chemists can tell of risk, but not of safety (Sir G. Buchanan, Royal Commission on the Metropolitan Water Supply, 1894), which is a mere truism, as the desired safety is but the absence of risk. Imagine a board of railway directors (if I may venture on the supposition) taking the view that as an engineer can only tell of risk and not of safety, any examination of their bridges was worthless, as it could not "prove the bridge incapable" of breaking, or, to use Dr. Thresh's own expression, he will "never be justified in certifying that it can be used absolutely without risk." The answer to this seems to be that there will always be cases of engineering accident, and equally of water pollution from unforeseen causes; but such occurrences will be more frequent if the more important methods of safeguard are disparaged and despised because they do not cover the whole field of inquiry.

No waters have been more thoroughly and continuously examined than the supplies of the London Water Companies; they have been violently attacked on *a priori* alarmist grounds, and strenuously defended on the results of chemical analysis, and yet, notwithstanding the myriads of microbes and the brigades of bacteria shown to inhabit every gallon of the river water, a Royal Commission had reported clearly and unmistakably in their favour. In reference to the bacteriological aspect of the question, they say that "as regards the diseases typhoid and cholera, which are the only ones known to be disseminated by water, there is no evidence that the water supplied to consumers in London is not perfectly wholesome"; and they further add: "We are strongly of opinion that the water as supplied to the consumer in London is of a very high standard of excellence and purity." These weighty conclusions are the outcome of a long and thorough inquiry; and the most important part of the evidence on which they are founded is the chemical evidence of the standard of purity, which is only confirmed and strengthened by the biological evidence, and the experience of the responsible health officers for London. Dr. Thresh, however, would set this all aside as of trifling importance compared with the results obtained from inspection and knowledge of the history of the water. Infor-

mation as to the results of inspection and the history of the waters was indeed abundantly supplied, some of the most alarming character highly coloured with individual prejudice; but such information could not outweigh the impersonal irrefragable results obtained by scientific chemical methods. After the experience we have gained during the past thirty years, I maintain that the chemical examination of water stands in a stronger and more assured position than ever, and gives information of the highest value for judging of the quality of potable water.

NOTE ON UNUSUAL SPECIMENS OF MILK.

BY SIR CHARLES A. CAMERON.

It seems a little hard on a vendor of milk which contains more than 4 per cent. of fats, to certify that it was largely adulterated with water. I have had frequently to do so. The latest case of the kind occurred during the present week. Sergeant Sheridan, R.I.C., Food Inspector, Enniskillen, submitted to me a specimen of milk which contained 5.26 per cent. of non-fatty solids and 4.6 per cent. of fats. Assuming that the milk when pure contained the assumed minimal amount of non-fatty solids, 61 per cent. of its weight of water must have been added to it in order to have reduced the non-fatty solids to 5.26 per cent. I may here remark that it is the percentage of water added to milk, and not the percentage of added water in it, that should be stated in the certificate. In the above the certificate should state as follows: "This is milk to which at least 61 per cent. of its weight of water has been added as an adulterant, making thereby a mixture of 161 parts of milk and water."

A specimen which was examined a short time since for the Croom (co. Limerick) Creamery contained 5.2 per cent. of fats, but according to the 8.5 per cent. non-fatty solids standard it was adulterated with 19 per cent. of water.

DUBLIN, *March 22*, 1895.

The Use of Barium Thiosulphate in Standardizing Iodine Solution. R. T. Plimpton and J. C. Chorley. (*Proc. Chem. Soc.*, 149, p. 38.)—For standardizing iodine solutions the authors recommend the use of barium thiosulphate, prepared by mixing warm solutions of 40 grammes barium chloride and 50 grammes sodium thiosulphate, each dissolved in 300 c.c. of water, the crystalline precipitate being washed and dried at 30°.

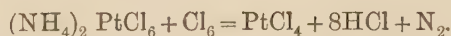
In the titration a weighed quantity of the BaS_2O_3 , H_2O is shaken with water in a stoppered bottle, and iodine run in until the salt is almost dissolved, when starch is added as a final indicator. Care must be taken to shake the bottle well after each addition of iodine.

The advantages claimed for the process are that barium thiosulphate, which has a high molecular weight, is easily obtained pure, keeps well, and reacts readily with iodine, while the progress of the reaction is marked by the gradual disappearance of the crystals.

C. A. M.

Uselessness of Kjeldahl's Method for Determining Nitrogen in Platino-Chlorides. Delephine. (*Bull. Soc. Chim.*, 1895 [3], xiii., 222.)—A sample of trimethylamine platino-chloride gave 3.88 per cent. of nitrogen, instead of 5.15 per

cent., when treated by the Kjeldahl method as usually conducted, permanganate being used as an oxidant. Ammonium platino-chloride gave 1.89 per cent. of nitrogen instead of 6.26 per cent. The author attributes the deficiency of these results to the fact that platinum tetrachloride easily loses chlorine, which may be expected to decompose the ammonia or amine in the platino-chloride in some such manner as the following :



[The author does not appear to have tried to effect the determination without the use of a drastic oxidizing agent such as would certainly liberate chlorine in the reaction flask.]

A. G. B.

Colouring Matter in the Californian Red Wines. W. D. Bigelow. (*Jour. Amer. Chem. Soc.*, 1895, xvii., pp. 213-218.)—In addition to the difficulty of distinguishing some of the substances used for colouring wines from the natural colouring matter of the grape, there are the further difficulties that the colouring matter of wine changes with age, and that different reactions are obtained with wines of the same age, but of different varieties or from different districts. With the object of comparing the reactions obtained with Californian wines with those with European wines, the author examined ninety-four samples of the former, varying in age from one to seven years.

Three classes of reagents were used: 1. Those giving a red, blue, or violet colour with wines containing foreign colouring matter, and usually a green or grayish-green with pure wines; for example, lead acetate, sodium carbonate, and bicarbonate borax and copper sulphate. 2. Certain metallic oxides (*e.g.*, manganese dioxide and lead dioxide); these were found to destroy almost all colour in Californian wines when used in the proportions recommended for French wines. 3. Methods in which chalk was used, treated with albumen and charged with various reagents.

The general conclusions arrived at were that in Californian wines the colouring matter was much more uniform than in European wines. The reactions were not always the same as with European wines, a gray or yellowish precipitate being sometimes obtained with reagents said to give green or grayish-green with French wines. On the other hand, no reactions were obtained which were characteristic of wines coloured with vegetable pigments.

C. A. M.

The Detection of Hydrogen Peroxide in Green Plants. A. Bach. (*Comptes Rendus*, 1894, cxix., 1218; through *Chem. Zeit.*)—The author, for the purpose named in the title, uses a reagent containing 0.03 grammes of potassium bichromate and 5 drops of aniline in 1 litre; 5 c.c. of this liquid are mixed with 5 c.c. of the solution to be tested, and to the mixture is added 1 drop of a 5 per cent. solution of oxalic acid. In the presence of hydrogen peroxide a red-violet coloration is produced. Tests made on 35 plants showed the presence of hydrogen peroxide in 18, while in 5 no reaction took place, and in the case of 2 the result was doubtful. The reaction is said to be recognisable in a solution containing 1 part of hydrogen peroxide in 1,400,000.

B. B.

Solvents for Perchromic Acid. W. M. Grosvenor, junr. (*Jour. Amer. Chem. Soc.*, 1894, xvii., 41; through *Chem. Zeit.*)—The author has examined the effect of a number of solvents on perchromic acid generated in the usual way from chromic acid and hydrogen peroxide. The following liquids do not dissolve perchromic acid: carbon disulphide, benzene, oil of turpentine, castor-oil, oil of wintergreen, oil of bergamot, kerosene, paraffin-oil, chloroform, carbon tetrachloride, toluene, nitro-benzene and aniline. The following liquids, on the other hand, dissolve perchromic acid: ethyl acetate, ethyl valerianate, amyl valerianate, amyl chloride, amyl butyrate, amyl formiate, amyl acetate. The colour is most stable in ethyl acetate, being permanent for 23 hours. The results are not entirely in accord with those of Griggi, who found that perchromic acid is more stable in amyl alcohol than in ether.

B. B.

The Detection of Arsenic in the Presence of Selenium. L. Dawydow. (*Farmazeft*, 1895, iii., 1; through *Chem. Zeit.*)—The so-called Bettendorf's reagent, that is to say an acid solution of stannous chloride, is useful for the detection of arsenic in quantities as small as 0.1 milligramme in 1 c.c. of water, but is not available in the presence of compounds containing such easily reducible substances as mercury, gold, tellurium and selenium, as these substances are separated in the elementary state. Thus a solution of selenious acid (1:1000) gives an immediate red precipitate with stannous chloride capable of masking a precipitate of arsenic; even with a solution ten times as dilute, a brownish coloration is produced. The presence of selenious acid retards the evolution of arseniuretted hydrogen in a Marsh's apparatus, and hinders the formation of an arsenical mirror. A series of experiments has shown that the definiteness of the mirrors obtained diminishes with increasing amount of selenious acid. For example, 1 milligramme of arsenious acid, when tested for in the presence of 18 milligrammes of selenious acid, failed to give a mirror even after one and a half hours, provided the evolution of hydrogen was slow; although when the stream of gas was rapid a mirror was obtained, the definiteness of which was favoured by leading a stream of hydrogen from an extraneous source through the Marsh's apparatus. When the proportion of arsenious acid was only $\frac{1}{100}$ of the selenious acid, no mirror could be obtained. The author has not proved whether this suppression of arseniuretted hydrogen is due to the formation of a compound of arsenic and selenious acid, or to the occurrence of the arsenic as solid arseniuretted hydrogen under the particular conditions obtaining. It is therefore advisable, in examining such materials as sulphuric acids and other sulphur compounds in which both arsenic and selenium may be present, to precipitate both by means of sulphuretted hydrogen, and to treat the resulting precipitate, consisting of sulphides of arsenic and selenium, together with free sulphur, with ammonium carbonate, thus removing the arsenic and allowing of its identification in the ordinary manner.

B. B.

Examination of Liquid Carbonic Acid. L. Grünhut. (*Chem. Zeit.*, 1895, xix., 505, 555.)—The examination of liquid carbonic acid is a matter which occasionally engages the attention of the commercial analyst, although but little has been pub-

lished on the subject. The only note dealing with the presence of impurities which has come to the notice of the author is one by Fleck, who stated that when strong, crude hydrochloric acid containing arsenic is used in preparing carbonic acid, some risk exists of arsenious chloride passing over into the compressors. The ordinary method of determining the freedom of the gas from gaseous impurities by absorption in caustic alkali solution, in the usual manner of gas analysis, needs no special description, and only requires the comment that in the author's experience the presence of more difficultly condensable gases hinders the liquefaction of the carbonic acid, and is therefore avoided by the manufacturer.

Other impurities have, however, been repeatedly detected. Liquid carbonic acid, although of apparently 100 per cent. purity, frequently has an objectionable smell, which impairs the quality of aerated liquids made by the aid of the gas. A product of this description gives a brownish colour to strong sulphuric acid, and slowly decolorizes dilute permanganate. The test with permanganate should be carried out both in acid and alkaline solution, as certain of the possible impurities in the carbonic acid react only under the one condition and certain others under the other. It is common to find a considerable amount of a brown turbid liquid left in the steel cylinders after the carbonic acid has been used. The author has obtained as much as 70 grammes of this impurity from cylinders originally holding 10 kilos of carbonic acid. On filtering this liquid a residue of from 1 to 2 per cent. of the weight of the liquid is separated, and consists of hydrated ferric oxide and a small quantity of organic matter. The filtered liquid deposits a considerable quantity of ferrous-ferric hydroxide on exposure to air, presumably from the oxidation of some iron compound which it holds in solution. When freed from this deposit, the final clear liquid is found to contain glycerin. The following analyses give some idea of the nature of the residual impurities found in carbonic acid cylinders, and indicate the variable character of this material :

			I.	II.	III.
Glycerin ...	...	...	0.81	0.33	6.63
Other organic matter	...	...	0.28	—	0.92
Ferrous oxide	...	...	0.45	0.40	0.84
Other mineral matter	...	...	0.03	0.07	0.24

The remainder of the material is presumably water, although no explicit statement to that effect is made. The origin of the glycerin is not obvious, but it is possibly used in the compressors, and carried over into the carbonic acid receiver. Much more important as regards the flavour of the product are the iron compounds, the presence of which cannot be entirely accounted for by the action of the water saturated with carbonic acid which finds its way into the cylinders, and is free to act upon their walls. By direct experiment the maximum quantity of iron that can be held in solution as ferrous carbonate by water charged with carbonic acid has been found to be equivalent to 0.056 per cent. of FeO . Contrasted with this is the fact that the residues from the three cylinders examined contained 7 to 15 times as much iron as is possible on the assumption that the metal is present as ferrous carbonate. It is probable that glycerin itself has a solvent action, not by direct attack of the iron, but by increasing the solubility of ferrous carbonate formed in the ordinary manner.

The author considers that the detection of this dirty ferruginous liquid containing glycerin in the cylinders which he has examined, affords a basis for explaining the cause of the disagreeable taste and smell of the carbonic acid and of aerated liquids prepared from it. The gas as it escapes from the cylinder must be charged with a fine spray of the impure liquid, the proportion of impurity increasing as the contents of the cylinder diminishes, owing to the fact that the impure liquid is heavier than liquid CO_2 , and therefore remains at the bottom of the cylinder comparatively undisturbed until the bulk of the gas has been drawn off. The observations here recorded point strongly to the necessity for more careful scrubbing and drying of the carbonic acid before it is bottled, and make it incumbent on the technical chemist not to content himself with a determination of the substantial purity of the carbonic acid itself, but also to make a special determination of any residual liquid that may remain in the cylinder after the gas has been blown off. B. B.

Simplified Method for Determining Phosphoric Acid by Means of Molybdate Solution. J. Hanamann. (*Chem. Zeit.*, 1895., xix., 553, 554.)—Where speed is not a prime necessity, separation of phosphoric acid by means of molybdate solution and subsequent conversion into magnesium pyrophosphate must remain the standard method. For rapid determinations, however, any process which permits of obtaining the yellow precipitate of phosphomolybdate of constant composition is worthy of attention. The main difficulty in the way of such a process consists in the tendency of ordinary molybdate solution to deposit molybdic acid on heating. The difficulty can be met either by using a molybdate solution, from which all superfluous molybdic acid has been separated by repeated boiling, or by adopting a molybdic solution of such a character that it can be relied upon to precipitate phosphoric acid in the cold, the precipitation being, of course, aided by stirring. A molybdic solution possessing this quality is one containing 100 grammes of molybdic acid, 1 litre of 10 per cent. ammonia and 1.5 litre of nitric acid having a specific gravity of 1.246. Solutions containing phosphoric acid are completely precipitated by this molybdic mixture by half an hour's vigorous stirring in the cold. The precipitate can be ignited until it acquires a pure blue-black colour, when it will contain 4.018 per cent. of phosphoric acid. In carrying out this process the bulk of the precipitate should be removed from the filter, which should be ignited separately. If a first ignition fail to give a mass of uniform blue-black colour, the precipitate should be moistened with ammonia, dried, and ignited again. The ignition preferably should be conducted in platinum, with the crucible resting on a piece of platinum gauze, which should glow red-hot while the bottom of the crucible is not visibly red. B. B.

The Use of the Mohr-Westphal Balance in Milk Analysis. C. H. Wolff. (*Zeit. für angewand. Chemie*, 1895, Heft v., pp. 134-137.)—By a modification of the Liebermann-Székely method the Mohr-Westphal balance can be used for the direct estimation of the percentage of fat in milk, as well as for the specific gravity. Fifty grammes of the milk are well shaken in a well-corked 200 c.c. flask with 5 c.c.

of KOH of 1.27 specific gravity. Fifty c.c. of petroleum ether (specific gravity 0.663) are then added and the mixture well shaken till an emulsion is formed, when 50 c.c. of alcohol (95 to 96 per cent.) are added and the shaking repeated four or five times, the flask being allowed to stand four or five minutes between each shaking. Twenty c.c. of the clear petroleum-ether layer, which now contains all the fat, are removed by a pipette, with its upper tube bent at an obtuse angle, and its lower tube passing through a cork, which fits the 200 c.c. flask. The 20 c.c. are evaporated in a previously weighed flask on a sand-bath or hot plate, and the residual fat determined directly in percentage on the Westphal balance. For weighing a small stirrup scale and three riders (2.0 gramme, 0.20 gramme, and 0.02 gramme) are required. The empty fat flask and scale are substituted for the sinking weight of the balance, and should be so counterpoised that the addition of the 2 gramme rider below the flask produces equilibrium. When weighing the residue of fat, if the removal of this 2 gramme rider produce equilibrium, the amount of fat must be 2 grammes, which would correspond to 10 per cent. But since the percentage of fat is always less than 10, it is necessary, after removal of the 2 gramme rider, to use the three riders on the beam in the usual way, and to deduct the sum of the numbers obtained from 10 per cent. Thus the amount of fat in the flask from 20 c.c. of petroleum ether (= 20 c.c. of milk) was 0.855 gramme, which, multiplied by five, gave 4.275 per cent. On the Westphal balance the riders gave the figures 5.725, which, deducted from 10 per cent., left 4.275 per cent. The results tabulated show that the method agrees with the ordinary analytical methods to the third place of decimals.

C. A. M.

Separation of Nickel and Iron. E. D. Campbell and W. H. Andrews. (*Amer. Chem. Journ.*, 1895, xvii., pp. 164-167.)—In many processes used to separate iron and nickel, the iron is precipitated first, and carries down with it more or less nickel. To avoid dealing with a bulky iron precipitate, several methods have been proposed in which nickel is precipitated first.

Classen* precipitates nickel as double potassium nickel oxalate in acetic solution, the double oxalate of iron being kept in solution.

Moore† converts both into double cyanides with KCN, and precipitates the nickel with KOH and Br.

Leroy‡ and Vortmann§ recommend electrolytic methods.

The authors have found the following method of separation accurate and easy. The mixed metals are dissolved in HNO_3 in an Erlenmeyer flask, an excess of 20 to 25 c.c. of the acid being used, and to this is added a solution of sodium pyrophosphate in warm water in the proportion of about 13 grammes of pyrophosphate for each gramme of the metal. The white ferric pyrophosphate which precipitates is brought into solution by adding cautiously a moderately concentrated solution of Na_2CO_3 until it just dissolves. The solution is filtered through asbestos into a 500 c.c. flask, and the nickel precipitated as brick-red nickelous xanthate by adding to the cold

* *Zeit. Anal. Chem.*, 1879, pp. 189-193.

† *Chem. News*, 1891, vol. lxi., p. 194.

‡ *Chem. News*, 1887, vol. lvi., p. 3.

§ *Monat.*, 1893, vol. xiv., p. 537.

solution 2 grammes of potassium xanthate freshly dissolved in a little water, the stoppered flask being shaken for ten minutes to complete the precipitation. The precipitate is then filtered off on asbestos, washed immediately with a 1 per cent. solution of potassium xanthate, and dissolved off the filter with freshly diluted (1 : 1) fuming HNO_3 .

Two c.c. of slightly diluted H_2SO_4 are added to the filtrate, and the liquid boiled till HNO_3 is completely expelled and fumes of sulphuric anhydride begin to appear. The nickel sulphate thus obtained is dissolved in a small quantity of water, and the iron present precipitated by a slight excess of ammonia. The ferric hydroxide is filtered off, dissolved in H_2SO_4 and reprecipitated with ammonia, the filtrate being added to the former filtrate. Even when much iron was originally present, the ferric hydroxide from the nickel solution rarely exceeds 0.003 gramme. The nickel in the solution of nickel sulphate may then be determined, either electrolytically by transferring it to a large platinum dish, adding 3 grammes of disodic-hydric phosphate together with 25 c.c. of strong NH_4OH , and depositing the metal by means of a current of about 0.14 amperes per 100 sq. cm. of the dish for twelve hours, or a volumetric method may be used. In the latter the nickel is determined by means of a standard solution of KCN , with AgNO_3 , followed by KI as an indicator, the suspended silver iodide giving an opalescence to the solution, which does not clear up until all the nickel has been converted into potassium nickel double cyanide.

The following table shows the accuracy of the method :

Iron added. Grammes.	Nickel added. Grammes.	Nickel recovered. Grammes.	Gain or loss. Grammes.	Method.
0.2105	0.08892	0.08910 + 0.00018		Electrolysis.
1.0000	0.03430	0.03435 + 0.00005		
1.0041	0.05298	0.05345 + 0.00047		
1.0043	0.10824	0.10825 + 0.00001		
2.0043	0.02690	0.02740 + 0.00050		Volumetric.
1.0010	0.00100	0.00089 - 0.00011		
1.0086	0.06578	0.06532 - 0.00046		
1.0066	0.07582	0.07583 + 0.00001		
1.0057	0.08017	0.08050 + 0.00033		
1.0071	0.09389	0.09381 - 0.00008		

C. A. M.

Extracts from the Proposed Austrian Alimentary Code. Wine. (*Bull. de l'Assoc. belge des Chimistes*, 1895, pp. 177-182.)—The substances which are allowed to be added before or after fermentation are: (a) Grapes fresh and dried, or their juice. (b) Alcohol pure, and some cognac. In grape wines the quantity of added alcohol must not exceed 2 per cent., and the total quantity of alcohol must not be more than 16 per cent. by volume. The following wines are exceptions to this: Old Tokay, 18 per cent. (Sweet Tokay, 16 per cent.); Malaga, 18 per cent.; Greek, Cyprian, Asiatic, Californian, and Cape wines, 20 per cent.; Australian, 21 per cent.; Port, 23 per cent.; sherry and Marsala, 25 per cent. In Sicilian wines the maximum of 27 per cent. is quite exceptional. (c) Cane-sugar and invert sugar. (d) Pure carbonic

acid. (e) Pure calcium carbonate. (f) Clarifiers not injurious to health, such as tannin, egg albumen, etc. Substances prohibited are: Alumina and magnesia preparations, sulphites, mineral acids, colouring matters from tar and other foreign materials, glucose, molasses, cane and invert sugar (impure), impure alcohol, salicylic acid, glycerin, aromatic bodies and substances injurious to health.

In judging as to the purity of a wine of a special vintage, it is necessary to base one's conclusion on the analysis of wines from the same district and of the same age.

Extract.—Wines completely fermented should yield at least 14 grammes per litre. Those containing less than that amount are to be suspected unless it be found normal for wines of the same kind and age. After removing the fixed acids, the residue should still be 11 grammes per litre.

Mineral Matter.—At least 1.3 grammes per litre in normal wines.

Ash.—Should not, as a rule, exceed $\frac{1}{10}$ of the total extract.

Glycerin.—The relation to the alcohol is from 7 to 14 per cent.

Free Acid.—In natural wines, containing about 8 grammes of acid per litre, the proportion of free tartaric to the fixed acids is as 1 to 5 or 6.

Sodium Chloride.—Not more than 0.05 grammes per 100 c.c., unless the wine come from a district with soils rich in chlorides.

Sulphuric Acid.—0.92 gramme of SO_3 per litre is the usual maximum.

Phosphoric Acid.—In certain cases gives useful indications, e.g., in the case of medicinal wines (Austrian and Hungarian *vins de santé* contain at least 0.6 gramme P_2O_5).

Nitrogen.—According to researches made at Klosterneuberg experimental station, natural wines rarely contain less than 0.07 gramme, or more than 0.08 gramme per litre, though in certain isolated cases it has been found as high as 1.35 gramme. Less than 0.07 gramme is suspicious.

Nitric Acid.—Only suspicious when the diphenylamine reaction is very marked.

Sulphurous Acid.—According to the medical faculty of the University of Vienna, a wine containing more than 0.008 gramme per litre is to be condemned.

Most of the preceding estimations are made by the usual methods, and the only points calling for special notice are the determination of the extract and the search for foreign colouring matters. In wines containing up to 3 per cent. of extract, 50 c.c. are evaporated on the water-bath in a platinum basin and dried for two and a half hours. Those richer in extract are diluted until they do not contain more than 3 per cent. and treated in the same way. In the case of sweet wines it is preferable to obtain the extract from the specific weight, for which purpose Balling's table is serviceable.

In examining for vegetable colouring matters the wine is treated with an excess of lead acetate. The colour of the precipitate obtained with natural wines is bluish-gray to bluish-green. With the colouring matter of the bilberry a mauve colour is obtained, and with that of the elder a greenish tint. With the colouring matter from the leaves of the cochineal oak (*Quercus coccifera*) the colour is reddish-violet.

In searching for coal-tar colours the lead acetate precipitate is filtered, the filtrate agitated with amyl alcohol, and the coloured amyl alcohol examined; 100 c.c. of the wine should be used, and 30 c.c. of lead acetate.

C. A. M.

REVIEW.

CHEMICAL ANALYSIS OF OILS, FATS, AND WAXES, AND OF THE COMMERCIAL PRODUCTS DERIVED THEREFROM. From the German of Professor Dr. R. BENEDIKT. Revised and enlarged by J. LEWKOWITSCH. (Macmillan and Co., 1895. £1 1s.)

Before entering into a discussion of the contents of this valuable work, we must take exception to the English editor's opening sentence in the preface, that "there has not hitherto been any English work dealing especially with the chemical analysis of oils, fats, and waxes." One of the volumes of Mr. Allen's great work on "Commercial Organic Analysis" deals most "especially" with the subject. Dr. Alder Wright's work, which, by the way, has the right of priority to the title chosen by Dr. Lewkowitsch, and which was published only last year, also deals "especially" with it, to say nothing of the numerous fairly complete monographs inserted in several chemical encyclopedias and dictionaries. The English editor of the work under review might have given credit where credit was due. To Mr. Allen in particular we owe so much of our knowledge of the composition, and what is the same, of the analysis of oils, that no writer for years to come can afford even to appear to overlook his work.

The reader cannot fail to be struck with the fact that of late years by far the greater part of the advance which has been made in the knowledge of the chemistry of oils is due to the analytical chemist, and not to the academical investigator. With the exception of the work of Hazura and his coadjutors (a work which stands in urgent need of confirmation and development), no very important addition has been made to the broad theoretical foundations laid long since by Chevreul and Liebig and their pupils, while, on the other hand, the analyst has most industriously multiplied and developed his methods. The measure of the proportions of free fatty acids, and of the amount of alkali requisite for neutralizing the total fatty acids, the measure of the proportions of the glycerides, volatile fatty acids, the insoluble fatty acids, hydroxyacids, and of the unsaturated fatty acids, with the isolation and determination of the alcohols, and other unsaponifiable matters, are all advances made during the last twenty years, and most of them are of still more recent origin. These now supply analytical data of infinitely higher scientific value than the old colour reactions and physical differences with which the last generation of chemists contented themselves.

The work deals most fully and clearly with the determination of these "constants" of fatty and allied bodies, and with their interpretation.

From the general part of the work, the intelligent student will at once realize that there is still need for a vast amount of further investigation. Essentials, like the separation of unsaturated from saturated acids, the determination of one saturated fatty acid in the presence of others, the quantitative estimation of the various groups of the unsaturated fatty acids, are even now almost in embryo, and until these and other allied problems are fully solved, accurate fat analysis will remain an impossibility. Indirect methods, it is true, exist in plenty, but none of these are beyond criticism, and many involve assumptions which are unwarranted. Thus

the indirect determination of palmitic and stearic acids from the molecular weight, as deduced from the titration of a mixture, presupposes that only the two acids named are present, and the proof of this is hardly ever obtainable. More complex still is the problem when unsaturated acids are present. The iodine number is often translated into percentages of oleic acid; but this is obviously wrong, unless there are no acids with less hydrogen than oleic present, yet no adequate means are at hand to prove their absence.

The special parts of the work, dealing with the constants and properties of individual oils, fats, and waxes, are very complete, and contain an immense amount of information. The tabular statements interspersed throughout this part are particularly valuable, and in this respect the work is an improvement on the original edition of Benedikt. Never before has so large a mass of similar material, for the most part trustworthy, been collected together. Had the authors done no other work than thus to collect data, they would have laid chemists under a great obligation; but when the whole scope of the work is considered, it can safely be said that no chemist who is called on to analyse fatty bodies can afford to be without the book. We must specially mention its value to the public analyst, though we are sorry to see that *THE ANALYST* is a journal apparently little known either to the author or his translator. Several important contributions, especially on the subjects of butter and lard, which were originally published in *THE ANALYST*, are attributed to other journals, erroneously described, or wholly ignored. As regards butter, the reference to adulteration with clay, chalk, gypsum, and flour, might with advantage have been omitted. The conversion of Reichert numbers into Reichert-Wollny figures by multiplication of the former by 2 is unjustifiable, the factor being more nearly 2.2.

There are a few errors in the book, taken over by the English editor from the German author. Thus, in Herbig's modification of the Benedikt-Zigmondy method for the determination of glycerin (p. 163), the amount of permanganate requisite is not clearly given—6.87 parts for one of glycerin are insufficient, half as much again being absolutely necessary, or the results will be found too low in almost all cases.

The method for the analysis of beeswax, depending upon the determination of the acid value and the ether value, is erroneously attributed to Hübl; and it is further stated that "Hehner adopts Hübl's method, with the only difference that he substitutes methyl alcohol for ethyl alcohol," etc. Hübl's paper on wax analysis was published in the September number of Dingler's *Polytechnisches Journal*, 1883, the date of the writing of the paper being July, 1883. Hehner's paper was read before the January meeting of the Society of Public Analysts, and was published in the February number of *THE ANALYST*, 1883, six months before the appearance of Hübl's paper. It is quite possible that Hübl's work on the subject was quite independent, but it was certainly not antecedent. Benedikt, like most other German authors, not understanding the mysteries of methylated spirit—a product peculiar to England, and a curse to English chemists—translates methylated spirit as "methyl alcohol." But the English editor might have known better than to repeat the error, which a glance at the original paper would have prevented.

But these mistakes and omissions are trifles compared with the mass of sound information contained in the book, which we cordially recommend to the readers of *THE ANALYST*, partly on account of its intrinsic value, but more strongly still on account of the help and stimulus it must prove to investigators of a particularly difficult and important division of chemistry.

O. H.